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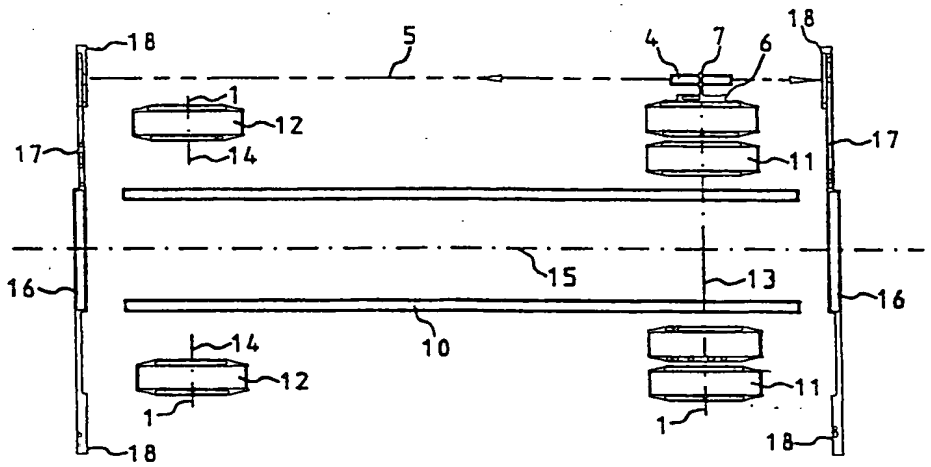

(57) Abstract

The present invention relates to a system for measuring the wheel settings of a vehicle and comprises a holder (6) which is mounted on the outside of each separate wheel or wheel-pair of the vehicle. The holder (6) is fitted with a trunnion, (7) which is caused to coincide with the rotational axis (1) of a respective wheel, a beam source, for instance a laser projector (4), mounted on the trunnion (7). The beam source is intended to illuminate alternately at least two measuring scales (18) at respective ends of the vehicle which extend transversely to a plane which includes the longitudinal axis of the vehicle. Each measuring scale is comprised of an optoelectronic detector unit which includes a plurality of photoelements (25) and at least one microprocessor (26) which functions to detect and compare the intensity of the light emitted by respective photoelements (25) when these elements are illuminated, and provides information relating to the precise position of the incident light beam on the measuring scale. The inventive measuring system also enables the wheel settings of a vehicle to be checked while the vehicle is in motion, in which case the measuring scales (18) are mounted on the vehicle and a separate computer connected conductively to the scales is placed within the vehicle.

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A System for Measuring the Settings of Vehicle Wheels

The present invention relates to a system for measuring the settings of vehicle wheels, said system comprising a holder which is attached to the outside of each individual wheel or wheel-pair and which is provided with a trunnion means which is intended to be aligned with the rotational axis of said wheel or wheel-pair, a light beam source, such as a laser projector, mounted on said trunnion means on the side of the vehicle in a plane common with the longitudinal axis of the vehicle and functioning to illuminate alternately at least two measuring scales which are arranged at respective ends of the vehicle and extend transversely to the longitudinal axis of the vehicle equidistant from the longitudinal centre line of said vehicle.

The invention is a further development of the measuring system described and illustrated in Swedish Patent Specification No. 7316572-2. In this basic construction, two measuring rods are attached to each end of a vehicle chassis and each rod is provided at its outer ends with a respective lateral measuring scale whose zero points lie equidistant from the longitudinal centre line of the chassis. The zero points lie slightly outside the wheels, so as to provide a free line of sight from scale to scale, outwardly of the outer surfaces of the wheels. For the purpose of determining the angular position of the rotational axis of each individual wheel or wheel-pair in relation to the longitudinal centre line of the chassis, a sighting instrument is mounted perpendicularly to the geometric axis of rotation. The method is based on generating a sighting line transversely to the extension of the wheel-axle rotational axis and essentially in a plane which is

common to the longitudinal axis, and by mutually comparing the optical extensions of the sighting lines to respective measuring scales in both directions with regard to the positions of the points in relation to the longitudnal axis. Deviation between the positions indicates that the wheel rotates obliquely to the longitudinal axis of the vehicle.

This measuring system has been found extremely useful in practice in the case of heavy vehicles, since such vehicles are relatively long and the measuring rods can be attached readily to the chassis frame of the vehicle. It is normally more difficult to attach the measuring rods to automobiles and the longitudinal distance between the scales has been much too short to ensure accuracy when measuring the wheel settings of such vehicles.

When using the system on heavier vehicles with a greater distance between the measuring scales, many users have found it difficult to read-off the measurement scales ocularly at the position of the sighting instrument, for instance a laser projector. This has made the need for improved and quicker reproduction of the measuring result appropriate.

An advantage would also be afforded if it were possible to position the measuring bars or rods independently of mountings on the vehicle. This would enable much longer distances to be applied between the measurement scales, resulting in improved measuring accuracy and also enabling the measuring system to be used in a similar fashion with both heavy vehicles and automobiles.

In order to achieve these advantages, it is necessary to provide for better reproduction of the measuring result

provide for better reproduction of the measuring result than that afforded by earlier known measuring systems of this particular kind. Accordingly, the present invention is characterized in that each measuring scale consist of an optoelectronic detector unit which includes a plurality of discrete photoelements mounted in a relatively long row on a circuit card or board; and in that the photoelements are connected conductively to a microprocessor which is mounted on the circuit card and which functions to detect and compare the intensity of the light emitted by respective photoelements when said elements are irradiated with light and to produce information relating to the precise position of the light beam incident on the measuring scale.

The present invention is also characterized in that the measuring scale has fixedly mounted therein a diffusor which functions to distribute the light intensity over a plurality of photoelements; and in that the microprocessor functions to compare the intensity of the light emitted by respective photoelements and to cause the measuring result to be indicated on a display connected to the measuring scale, subsequent to having calculated the centre-of-gravity of the broadened intensity curve.

According to further embodiment of the invention, the measuring result can be transferred to a separate computer connected conductively to the measuring scale and capable of indicating individual measuring results in a known manner and also of storing said results and combining separate part-measuring results in a known manner for presentation of a calculated result for a relevant wheel setting.

The measuring scales of the inventive measuring system

may be mounted on separate stands located outside the respective ends of the vehicle, and one or more measuring scales may be mounted adjacent the vehicle. All of the measuring scales are positioned so as to have the same lateral positions in relation to the vehicle centre line, irrespective of the positions of respective measuring scales in the longitudinal direction of the vehicle.

The inventive measuring system comprising measuring scales which are mounted on the vehicle concerned and a separate computer which is placed within said vehicle would enable wheel settings to be measured while the vehicle is in motion, which would be highly advantageous.

Other characteristic features of the invention will be evident from the following description and Claims. The invention will now be described with reference to the accompanying drawings, in which

Figure 1 is a simplified view from above of a vehicle whose wheels are to be checked with the aid of an inventive measuring system;

Figure 2 is a longitudinal, schematic view of a measuring scale provided with a row of photo-elements, and a microprocessor;

Figure 3 is a cross-sectional view of the measuring scale; and

Figure 4 illustrates the detection principle of the measuring scale.

Figure 1 illustrates schematically the measuring system applied to a vehicle having a chassis frame 10, two double-wheel rear wheels 11 and two front wheels 12. The rear wheels 11 are carried by a common axle 13 and

each of the front wheels 12 is carried by an individual axle 14. Also shown in the Figure is the longitudinal centre line 15 of the vehicle, this centre line having great significance when checking and adjusting the wheel settings of a vehicle.

In order to determine the position of the rotational axis 1 of a wheel, it is necessary to extend the rotational axis. This can be achieved by clamping onto the outside of the wheel, a holder 6 of a kind earlier known from the aforesaid Swedish Patent Specification No. 7316572-2. The holder 6 carries a moveable, adjustable trunnion means 7 which can be brought to a position in which it coincides with the geometrical axis of rotation 1 of the wheel, by rotating said wheel.

A stand 16 is positioned at right angles to the longitudinal centre line 15 of the vehicle, at respective ends of the vehicle. Mounted on each stand 16 is a pair of continuous, self-centering measuring bars 17 which are able to take different lateral positions in relation to the vehicle centre line 15, these lateral positions being contingent on vehicle width. Mounted at the ends of respective measuring bars 17 are lateral measuring scales 18, which are placed far enough from the vehicle to obtain free sight from scale to scale, outwardly of the outer sides of the wheels. For the purpose of determining the angular position of the rotational axis 1 in relation to the vehicle centre line 15, a light-beam source, for instance a laser projector 4, is pivotally journalled on the trunnion 7 on the holder and can be rotated on said trunnion 7 so as to irradiate each measuring scale 18 alternately. If the measuring scales show mutually the same values, the rotational axis 1 of the wheel is positioned perpendicular to the vehicle centre line.

If the measurement value of the rotational axis 1 of a wheel 12 on the forward measuring scales 18 is greater than the measurement value on the rearward measuring scale on the same side of the vehicle, there is obtained a positive value which is divided by the distance between the two measuring scales 18 and which gives a value of the rolling direction of the wheel per unit of length. If the measurement value on the rearward measuring scale is greater than the measurement value on the forward measuring scale on the same side of the vehicle, there is obtained, in an analogous manner, a negative rolling direction per unit of length (mm/m). These measuring values can be used to ascertain whether or not the wheel angles toe-in or toe-out occur on the vehicle concerned.

As before mentioned, the aforedescribed part of the measuring system is similar to the measuring system described in Swedish Patent Specification No. 7316572-2. Wide differences exist, however, in the design and applicability of the measuring scales of the known and the inventive systems. The earlier, linear measuring scales are constructed to be hung on measuring bars mounted in a vehicle, and the measuring scales are graduated solely linearly for ocular reading.

In the case of the inventive measuring system, each measuring scale 18 has the form of an optoelectronic detector unit, which is comprised of an elongated, profiled body 19 having embracing walls 20, 21, 22 on three sides thereof. The fourth side, the upper side, is provided with a longitudinally extending opening 28. The detector unit is provided with a linear metric graduations 29 along the imperforate sides of the opening 28, said graduations having a length greater than 30 cm. Each end of the body 19 is closed with an end plate

23.

Mounted in the body 19 is a circuit board 24 on which a number of known electronic components are mounted. It is not necessary to know the nature of these components in order to obtain an understanding of the invention, and consequently these components will not be described here. Also mounted firmly on the circuit board 24 is a relatively long row of discrete photoelements 25, preferably phototransistors. These elements are connected conductively to a microprocessor 26, a so-called microchip processor, which detects the intensity of the light emitted by each separate photoelement 25 and, on the basis thereof, calculates the centre-of-gravity position of a beam incident on the measuring scale 18. The result of this calculation is passed to a display unit 27 attached indirectly to the circuit board 24 and which illustrates the result in digit form, in a known manner.

The microprocessor 26 is also intended to activate an indicator lamp 33, when light impinging on the measuring scale 18 activates the microprocessor 26 for calculation of said gravitational centre position. The indicator lamp 33 is placed within the body 19 of the measuring scale, so as to be readily visible to the person carrying out the measurements. - The components of the measuring scale are powered electrically by a number of batteries 30 disposed within the body 19.

Mounted in the opening 28 on the upper side of the body 19 is an elongated lens 31 which magnifies the detector surface of the measuring scale 18, with the purpose of capturing possible movements of the beam source. The lens 31 has a low position in the opening 28, therewith protecting the lens 31 and also screening light which is obliquely incidental to the lens 31 and preventing said

light from having any appreciable influence on the photoelements 25.

A laser projector produces an intense, very narrow beam of coherent light, which impinges with high intensity on a very small area. In the present case, the intensity distribution of the light beam is preferably such that the beam will illuminate, or irradiate, a plurality of mutually adjacent photoelements 25 on the measuring scale 18. This is achieved by mounting a diffusor 32 beneath the lens 31 in the body 19, so as to distribute incident light on the measuring scale 18 to the photoelements 25.

Figure 4a illustrates by way of example an intensity curve of a laser beam delivered by the laser projector 4. Figure 4b illustrates an intensity distribution curve containing the same amount of monochromatic light, and Figure 4c shows the same curve in larger scale. The curve 4c illustrates the intensity of the light emitted by a plurality of mutually adjacent photoelements 41-46 in the measuring scales 18 and detected by the microprocessor 26. The microprocessor 26 calculates the centre-of-gravity point of the intensity curve so as to establish the exact position of the beam on the measuring scales 18 and produces output signals which indicate this position on the display in digit form.

It lies within the concept of the invention to transfer this measuring result to a separate computer unit (not shown) which includes memory functions and also a display on which the result, or parts of the result can be displayed. This known computer unit will thus indicate immediately the result of separate measuring processes, and can also store these part results for subsequent combination and presentation of a calculated end result

which determines the setting of the wheel concerned.

The inventive measuring system enables the wheel settings of a vehicle to be measured and ascertained while the vehicle is in motion. In this case, the measuring scales 18 are mounted on the vehicle equidistant from the vehicle centre line 15, and a computer unit is fitted within the vehicle and connected to respective measuring scales 18.

When a separate computer unit is used, less stringent demands are placed on the concentricity of the trunnion 7 with the rotational axis 1 and also on the lateral positions of the measuring scales 18 in relation to the vehicle centre line 15. This is because the separate computer unit stores each individual measuring result and calculates the mean value of these results and uses said mean value as a basis for the final calculation of the vehicle wheel settings.

It will be understood that the invention is not restricted to the exemplifying embodiments thereof and that these embodiments can be modified within the scope of the following Claims. For instance, the light beam may be generated by a source other than a laser, and photodiodes may be used as detectors in the measuring scale 18. The measuring result may also be reproduced in a manner different to that described in the specification.

CLAIMS

1. A system for measuring the wheel settings of vehicles, comprising a holder (6) which is attachable to the outside of each individual wheel or wheel pair and which includes a trunnion means (7) which is intended to be aligned with the rotational axis (1) of a respective wheel or wheelpair, a beam source, such as a laser protector (4) mounted on said trunnion means (7) on the side of the vehicle in a plane common with the longitudinal axis of the vehicle and functioning to illuminate alternately at least two measuring scales (18) which are lateralt graduated and arranged at respcetive ends of the vehicle and extend transversely to the longitudinal axis of said vehicle equidistant from the lpngitudinal centre line of said vehicle,
c h a r a c t e r i z e d in that each measuring scale (18) consist of an optoelectronic detector unit which includes a relatively long row of discrete photoelements (25) firmly mounted on a circuit board (24); in that the measuring scale (18) has fixedly mounted therein a diffusor (32) which functions to distribute the radiation intensity over a plurality of photoelements (25); and in that a microprocessor (26) which is connected conductively to said photoelements and which functions to detect and mutually compare the intensity of the light emitted by respective photoelements (25) when said elements are illuminated and to provide information relating to the precise position of the incident light beam on the measuring scale (18).

2. A measuring system according to Claim 1,
c h a r a c t e r i z e d in that the microprocessor (26) functions to detect and compare the radiation intensity of respective photoelements (25) and, subse-

quent to calculating the centre-of-gravity of the broadened intensity curve, produces output currents which cause the measuring result to be indicated in digit form on a display (27) connected to the measuring scale (18).

3. A measuring system according to Claim 2, c h a r a c t e r i z e d by means for transferring the measuring result to a separate computer connected conductively to the measuring scale (18) and functioning, in a known manner, to indicate individual measuring results, to store said individual measuring results and to combine said different measuring results for presentation of a calculated result which indicates the setting of the wheel concerned.

4. A measuring system according to Claim 3, in which the measuring scales (18) are mounted transversely on the vehicle whose wheel settings are to be measured, c h a r a c t e r i z e d in that a separate computer is mounted within the vehicle and enables the vehicle wheel settings to be checked while the vehicle is in motion.

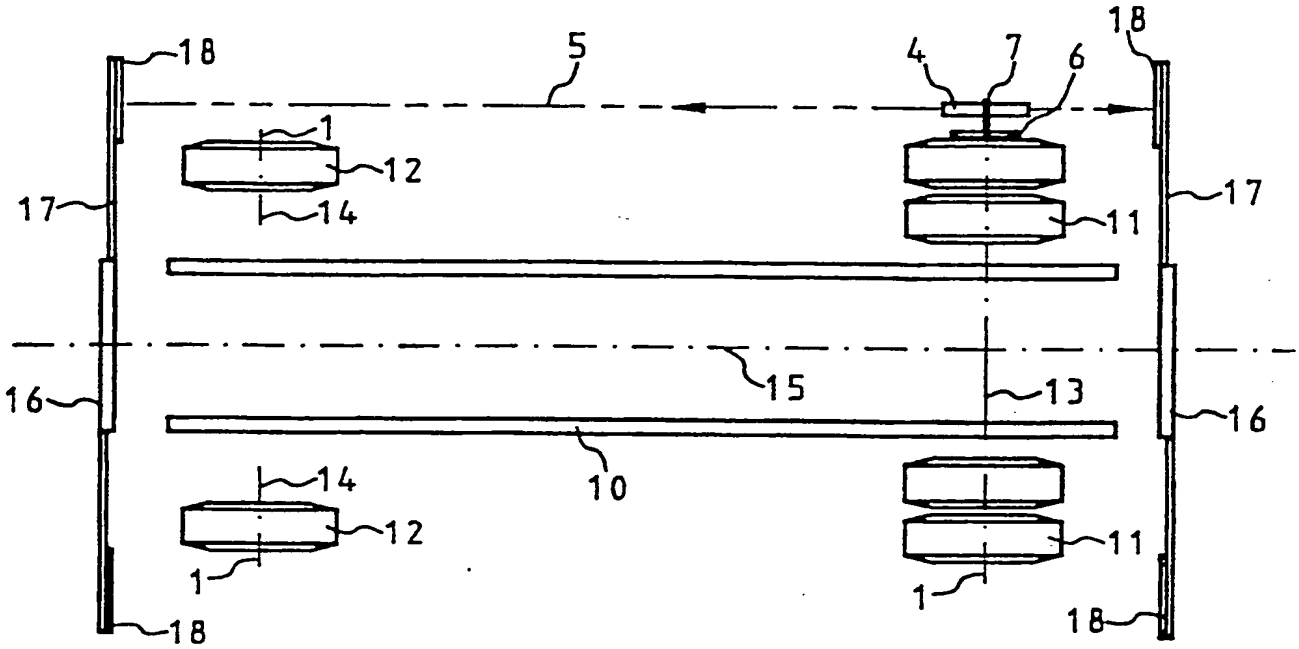

FIG. 1

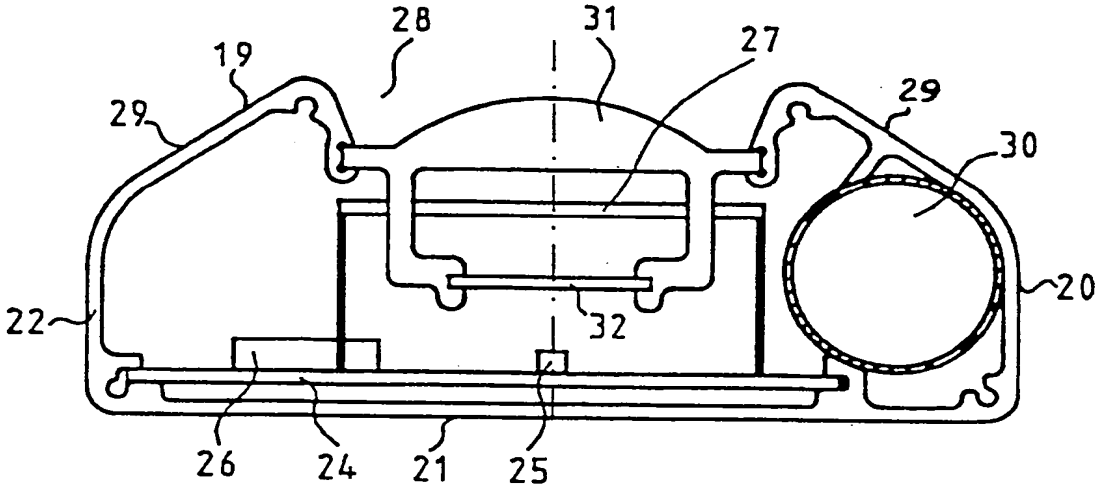

FIG. 3

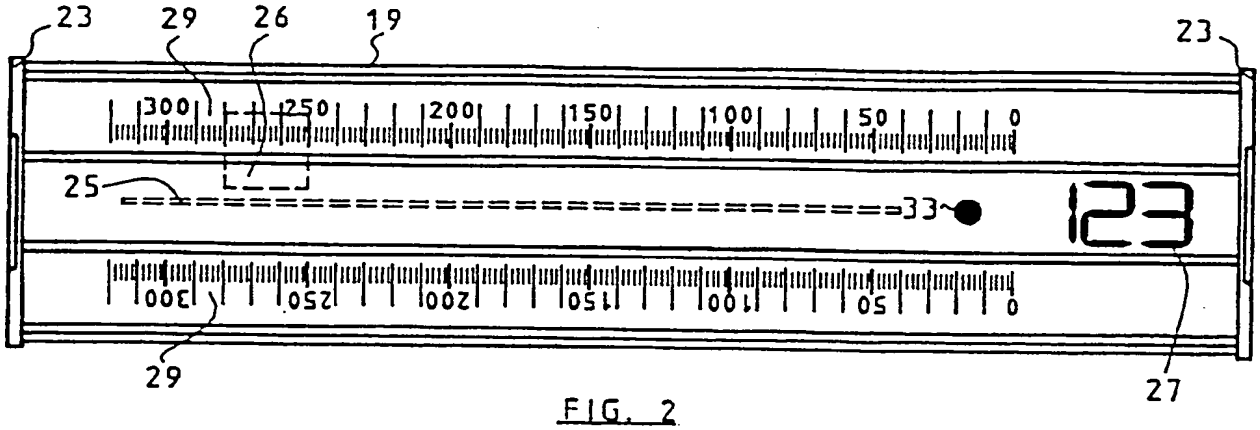

FIG. 2

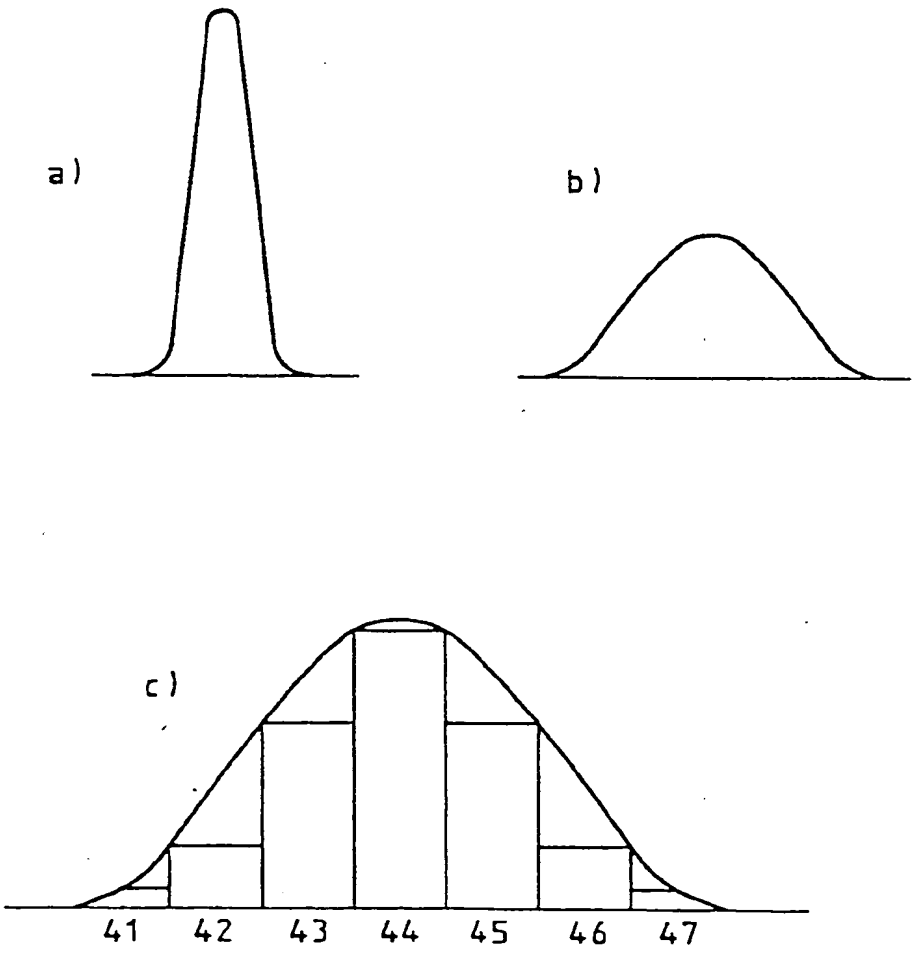

FIG. 4